Information Systems Division
CO-OPS Development Plan for Data Exchange and Dissemination

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Executive Summary

There are varieties of oceanographic organizations and institutions, which are providing oceanographic data via the internet via, FTP, voice systems and radio as well as other venues. However, much of the data is not well documented with descriptive metadata information, nor is the data in similar formats and easily accessible. Further, once the data is collected at a site, it most likely is not stored in an archival standard that is easy to search. Because of these inconsistencies between the various organizations and institutions, it is difficult for the end user to find their desired information. Ocean.US (http://ocean.us/), along with other cooperating oceanographic organizations, is making a strong push to standardize oceanographic metadata, data searches, data transport and data archiving. With these initiatives in mind, the Center for Operational Oceanographic Products and Services (CO-OPS) plans to be one of NOAA's organizations leading in the integration and exchange of oceanographic data.

The objective of this document is to provide a strategic plan on how CO-OPS proceeds with fulfilling the Ocean.US goal toward standardizing the acquisition, dissemination and archival process of oceanographic data. This document describes the existing major data acquisition programs that CO-OPS maintains, the types of data disseminated to the public as well as collaborative efforts that CO-OPS has with other organizations. It also presents a general description of the goals toward becoming a leading agency in sharing oceanographic data with the user community as well as long term archiving of the data.

This document serves as a general plan on how CO-OPS will proceed toward becoming a leading agency to accomplishing the Integrated Ocean Observing System (IOOS) vision presented by Ocean.US. It is not the intention of this document to be a definitive design for the implementation process. Subsequent technical documents will follow with more information on implementation of these ideas. This document does not supersede any other documents concerning the Data Management and Communications Plan provided by Ocean.US.

1. Introduction

1.1 Background and Project Principles/Goals

CO-OPS has developed several major data measurement and dissemination programs, which aid the maritime community in navigation of U.S. coastal waters, maritime safety, improve the efficiency of U.S. harbors and ports, and provide protection of coastal marine resources. Two of CO-OPS primary programs are the National Currents Program (NCP) and the U.S. National Water Level Observation Program (NWLOP). These two programs provide environmental observations in real-time for a variety of coastal locations around the United States.

This information is available on the web, radio and by phone. However, downloading data can be somewhat cumbersome, and knowledge behind how the data is obtained, the metadata, is not always complete.

In an effort to make data more accessible and user friendly to the maritime and scientific communities, oceanographic institutions and Federal/state governmental agencies are taking it upon themselves to create an Integrated Ocean Observing System (IOOS). In this system, these institutions and agencies will create a set of standards for metadata, data discovery, data transport and data archiving, for both observed and predicted oceanographic data. These standards will allow end-users relative ease in accessing and retrieving data through web portals. This type of access will also allow for searches in not just a single provider's database, but be able so search across many databases for the same data based on specific search criteria. This system design will be flexible and extensible, so that as new data types are added to databases, searching for them will not be difficult. Finally, not only will the data be made available to the end-user in real-time, but the data stored in predefined archival data formats at designated archiving centers will be searchable as well. These ideas are the guiding principles for the Data Management and Communication (DMAC) vision (Ocean.US, 2005):

1. **Interoperability** – systems functions cooperatively through seamless exchange of data.
2. **Open, easy access and discovery** – allow users ease of locating data and their metadata and documentation without having to know much about the data source, location and format.
3. **Reliable, sustained, efficient operations** – allow a highly reliable 24/7 real-time delivery of data streams for users with time-critical requirements.
4. **Effective user feedback** – Provide a continuous, vigorous outreach process addressing all level of users and addressing their requirements of how the DMAC process can grow and improve.
5. **Open design and standards process** – all standards and protocol definitions openly published so that organizations participating in IOOS may create functioning DMAC components based on these specifications.
6. **Preservation of data and products** – Archiving observations, data products and associated metadata in an efficient and automated manner

1.2 Benefits of CO-OPS Participation

In order for the IOOS program to take hold, many organizations and agencies will be required to communicate with one another, sharing ideas and information on creating not only a national oceanographic data sharing/distribution network, but a global one as well. By participating in IOOS, CO-OPS can learn and share best practices for data measurement, quality assurance and quality control, data dissemination and data archiving. From this sharing of ideas, CO-OPS can form formal partnerships with other organizations, which may allow CO-OPS to serve as a model agency for cooperation between different organizations. In addition, by serving as one of the leaders in the

IOOS development, CO-OPS can help guide the direction of how data standards will be derived, and development of data retrieval and transport systems for real-time data. Finally, CO-OPS may want to take the role of being a data-archiving center for not only NOS' own data, but other regional organizations.

1.3 Primary Objectives

The primary objectives for CO-OPS, concerning the IOOS program is to be a leader in setting up the backbone for the data search, retrieval and archival systems. This includes helping to set standards for metadata information for the oceanographic parameters. Other objectives include, serving as a data collection provider and a web portal to the data, and becoming an archiving site for those partner agencies that need assistance. Finally, help IOOS develop an outreach program to learn how to improve data collection, access and dissemination.

1.4 Assumptions and Constraints

The ability of CO-OPS to be an active partner in the IOOS program relies upon the assumption that guidance from the Data Management and Communication Steering Team (DMAC-ST) will be available in a timely fashion so that implementing the recommendations may be accomplished in a practical manner. In addition, availability of CO-OPS resource personnel may influence development of metadata, data servers and web access to the data. The addition of an additional server and related software creates another major data management system to administer.

2. Existing CO-OPS Data Sources and Types

2.1 National Current Program (NCP)

The National Current Program (NCP) measures the currents in the coastal and estuarine waters throughout the United States and produces various products and services from these measurements. In addition to real-time web products, the primary products have traditionally been predictions published in the Tidal Current Tables (TCT) and quality controlled data sets but the program continuously seeks to broaden its products through user requests and development. These products support NOAA, marine commerce, and weather and water missions. Current observations are made within the National Current Observation Program (NCOP), which uses numerous methods and technologies to make observations required by the program's customers. The NCP uses the data generated by NCOP projects and other sources to create high quality value added products (CO-OPS, 2005).

One product that is an important data information tool for the maritime community is PORTS® (Physical Oceanographic Real-Time System). This tool provides real-time quality-controlled oceanographic and weather data for maritime commerce to aid navigation through ports and harbors in the United States. It also has improved the safety and efficiency of the maritime shipping and coastal resource management.

PORTS® provides observations and predictions of water level, currents, salinity, and meteorological parameters such as winds, atmospheric pressure and visibility, as well as others. Several of the main parameters are described below with a brief description of their sensors.

2.1.1 ADCP (Acoustic Doppler Current Profiler)

The primary instrument used in the collection of current data is the acoustic Doppler current profiler or ADCP. This type of instrument can be mounted to a weighted base on the ocean floor, on a pier or set off a side of a boat. These profilers measure currents looking from the bottom of the ocean upwards, from the top of the water level down toward the bottom, or horizontally when the sensor is attached to the side of a pier.

There are two types of instruments primarily used in measuring horizontal and vertical current speed. They are the RDI Instruments and the SonTek. The RDI Instruments consists of NarrowBand and BroadBand sensors. Both bands use four beams in their measurements. The SonTek sensor uses three beams.

Current information products updated to the web for end-users are composites of observed along channel current and cross channel depth (in feet) of the current below Mean Lower Low Water (MLLW) vs. time, observed along-channel current with predicted current and observed speed vs. time, 3 days currents and all currents. On most PORTS® web sites (http://tidesandcurrents.noaa.gov/d_ports.html), these composites are available. (For a breakdown of specific sensors, data measuring frequency, quality control procedures and examples of graphics available on most PORTS® web sites, see section 13.0 Appendix – Data Profile.)

2.1.2 Air Gap

Air Gap is an instrument that measures clearance between the water surface and bridges in units of feet. To measure the air gap, the microwave sensor, Miros SM094/50, is placed on the center span of a bridge. The sensor takes readings every six minutes to account for changes in water level, volume of traffic crossing the bridges, and air temperature, all of which cause bridge clearance to fluctuate. At the moment, this sensor is deployed at a limited number of PORTS® stations. The Air Gap products that are available for viewing are two composites, a one-day composite and a three-day composite.

2.1.3 CTD (Conductivity/Temperature/Depth (Pressure) Sensor)

In addition to current measurements other ancillary water measurements, water conductivity, water temperature and pressure, are taken at the PORTS stations. To measure the water conductivity, water temperature and depth of the sensors, two types of sensors are used, the Sea-Bird sensor and the Falmouth CT sensor. These sensors reside in a plastic tube, which is mounted to the side of the pier, extending out of the bottom of the tube. The products available to the user are a 3-day composite of salinity,

specific gravity and water temperature vs. time and a depiction of all salinity, specific gravity and water temperature for the current day.

2.2 NWLOP

Another major observational program that CO-OPS supports is the National Water Level Observational Program (NWLOP). The program's main goals are to provide the long-term water level records from which are derived the vertical reference datums used for surveying and mapping, dredging and coastal construction, water level regulation, marine boundary determination, tide prediction and for analysis of long-term water level variations and trends (CO-OPS, 2004). The backbone of the program is a network of about 175 continuously operation water level stations mainly operating in U.S. coastal zones, including the Great Lakes and Atlantic and Pacific.

Near real-time raw data is available to users at the CO-OPS Home Page on the web. Water level data along with ancillary meteorological data are transmitted via Geostationary Orbiting Environmental Satellites (GOES) satellites to NOS approximately once an hour. These ancillary hourly measurements at NWLON station support NWS storm surge, and NOS PORTS and COASTAL program activities (CO-OPS, 2004).

2.2.1 Water Level Gauges

Water level is measured with three types of instruments Aquatrak WL Gauge, Strain Gauge and the Shaft Angle Encoder (SAE). These sensors typically are placed in a protective well. The SAE is used in possible freezing conditions or if the Aquatrak cannot be properly mounted. Typically, the SAE is installed in a sump, which protects it from freezing water. The measurements by the sensors are taken every six minutes and the information is transmitted by through the GOES satellites. Further processing of the water level data is applied to create hourly predictions, high and low tide predictions, monthly means and annual means.

Water level products that are found on the CO-OPS water level web site are preliminary, verified and historical data for stations around the U.S. and the Great Lakes and sea level trends. Water level information that are also displayed on the PORTS® web site are 3-day composite of water levels and meteorological parameters and water levels both predicted and observed above MLLW vs. time.

2.2.2 Meteorological Packages

Along with measuring current information, salinity and water level information, ancillary meteorological data is collected at most sites. The parameters are wind speed, direction and gusts, air temperature, water temperature, and barometric pressure. Composites of these parameters are available on the CO-OPS web page mentioned previously.

The wind sensor is mounted on top of a twenty-foot high fiberglass pole or a thirty food high steel meteorological tower. As much as possible, the placement of the sensor is in an area clear of obstructions. The air temperature sensor is mounted on the same types of poles as the wind sensor along with a radiation shield to protect the sensor from direct sunlight. Attachment of the water temperature sensor is typically to the sounding tube where the water level sensor is located. Generally, the barometric sensor is mounted inside of the sensor platform and it is vented to the outside for measurements.

3. Existing CO-OPS Methods for Data Exchange and Dissemination

3.1 Verbal, Fax, CD/DVD

There are several methods which CO-OPS disseminates data to the public. In any given month, on average, CO-OPS responds to approximately 195 telephone request, about 15 fax requests and sends out roughly 60 CD/DVDs. Many of the types of data requested by the public cover what is available online at the CO-OPS web site http://tidesandcurrents.noaa.gov/. These data may be observations and predictions of tides, currents, Great Lakes water levels, meteorological observations, and forecasts and nowcasts of water levels. In addition to observed and predicted data, datums, harmonic constituents and astronomical data are also available to the public. Many routine requests by users are for historical data since it is not in the active data bases.

3.2 FTP

Another method CO-OPS uses to provide data to public is through FTP (File Transfer Protocol). Through this method CO-OPS creates data and image files tailored to individual projects and organizations. GoMOOS (Gulf of Maine Ocean Observing System) and Caro-COOPS (Carolinas Coastal Ocean Observing and Prediction System) are couple of ocean monitoring projects that retrieve specific data for their studies. The National Data Buoy Center (NDBC), National Oceanographic Data Center (NODC), U.S. Army Corps of Engineers (USACE) and U.S. Geological Survey (USGS) are a few of the federal agencies that benefit from these specialized files. These data files may contain water level, water temperature, air temperature, and barometric pressure data along with other data information and may contain a single station or a specific area.

In addition to providing tailored real-time information via FTP, CO-OPS also provides gridded data files and graphics from the New York Harbor Observational Forecast System (NYOFS) model. These files contain water level observations, water level nowcasts, water level forecast and tidal predictions for various locations in the harbor. The forecast information allows for improved navigation, emergency response and other applications toward the ecosystem.

3.3 Voice Response System

This voice response system gives the latest real time PORTS® observations over the telephone. The caller chooses what data to hear from a menu. This system is available 24 hours a day, 7 days a week. The voice system utilizes the Voice Data Response system manufactured and sold by Syntellect called Vista. The phone numbers are listed on the CO-OPS PORTS® web page (Burton, 2004).

3.4 Web

The CO-OPS web site (http://tidesandcurrents.nos.noaa.gov/) is one of the primary ways of getting oceanographic data out to the maritime community. Users are able to retrieve information about tidal information for the U.S. coastal areas and the Great Lakes, as well as meteorological data such as wind speed, wind direction, pressure, and air and water temperatures. In addition to tidal information, real time oceanographic data is given through the PORTS® website. This information has proved to be in invaluable tool for the maritime community as ships navigate their way around the U.S. coast (Burton, 2004).

3.5 Other Special Methods of Data Dissemination

At the request of federal agencies, various universities and private companies CO-OPS generates user specific data files that are subsets of the ASCII files available through the CO-OPS web site. By tailoring these files for these individual users, they are able to FTP the files, process the data and use the information in a timely manner rather than having to scourer the web site looking for the data of interest, manually download and reformat the data themselves. Several of the federal agencies, which CO-OPS provides specialize data sets, are the National Weather Service (NWS), National Data Buoy Center (NDBC), United States Geological Survey (USGS) and the United States Army Corps of Engineers (USACE). In addition, CO-OPS generates special data files for federal agencies, various universities and private companies.

For example, two data sets that CO-OPS provides the NWS are the SHEF (Standard Hydrometeorological Exchange Format) data and the CREX (Character Form for the Representation and Exchange of data). The NWS FTPs the SHEF data from the NWS Gateway in six-minute intervals and the CREX is retrieved hourly. There are several Weather Forecast Offices (WFO), Monterey, CA, Sterling, VA and Clearwater, Fl, that have data sets containing water levels, and meteorological data created for them daily. In addition to creating specific data files, CO-OPS creates PICS (Ports Image Component System) graphics for private companies, such as Exxon. Exxon downloads these graphics for their internal web site so that their ships may use them to navigate the harbors and ports safely.

4. Existing Collaborations

4.1 Texas Coastal Ocean Observation Network (TCOON)

One of the first collaborative projects that NOS CO-OPS participated in was an agreement with the Texas General Land Office (GLO) in 1988. From this agreement, NOS and GLO began a program of technology transfer, providing GLO personnel with training that allows the state to conduct its own data collection, analysis and datum computations.

In 1991, this network of water-level gauges became the Texas Coastal Ocean Observation Network (TCOON). In 2003, the Division of Nearshore Research (DNR) assumed responsibility for operation and maintenance of TCOON. NOS' continues to provide oversight on the development of TCOON and participates in stakeholder meetings.

The TCOON stations collect water level, wind speed, barometric pressure, salinity, water quality and other meteorological data from the bays and estuaries in Texas. NOS maintain seven permanent stations, where their real time data is available on the web at Tides Online (www.tidesonline.nos.noaa.gov). Additional supplemental station information may be added to Tides Online during severe coastal storms. This additional information allows a greater spatial coverage of water levels before, during and after a storm. This level of coverage was not available prior to TCOON.

4.2 Carolinas Coastal Ocean Observing and Predicting System (Caro-COOPS)

In the fall of 2002, the NOAA Coastal Services Center awarded a grant to a partnership of universities to establish a regional observing system for the Carolinas. The Carolinas Coastal Ocean Observing and Prediction System (Caro-COOPS) establishes the capacity to monitor and model estuarine and coastal ocean conditions in the Carolinas. It further enhances the capability for real-time forecasts to mitigate natural hazards, supports the management of living resources and marine ecosystems, facilitates safe and efficient marine operations, and supports national security in the region.

The central goal of Caro-COOPS is to establish reliable forecasting tools for a suite of regional coastal ocean processes. The overall objectives are to:

- integrate information on the causal biological, chemical, and physical processes in the Carolinas' coastal ocean to provide a thorough understanding of how physical forcing and biological responses are coupled on regional spatial scales and seasonal and interannual time scales;
- assess the predictability of specific coastal processes and events;
- develop accurate forecasting models; and
- create tools for applying and evaluating these predictions in the context of "end-to-end" early warning systems.

5. Requirements

5.1 Definition of What CO-OPS Participation Means

For CO-OPS to participate actively in the IOOS program, the organization will have to take the initiative to improve and adhere to standards and protocols to support key functions of the IOOS Data Management and Communication (DMAC) plan. These functions include improvements on standardizing CO-OPS metadata, assisting in developing tools to aid in data discovery, improving data transport, data access protocols and must consider advanced archiving capabilities.

5.2 Definition of How CO-OPS Becomes an Active Participant

To become an active partner in the development of the IOOS program, as a data provider, CO-OPS should plan to participate on IOOS DMAC Expert Teams for Metadata, Data Transport and Access, Archive and IT Security. By participating on these expert teams, CO-OPS will have the opportunity to ensure that their varying data requirements are met.

5.3 Guidance for Being an Active Partner

Initially, examination and updating current metadata information for all of CO-OPS active stations so that it will be compliant with the Federal Geographic Data Committee (FGDC) needs to be accomplished. This involves covering the What, Where and When of each station and if possible, the How the data is measured by the sensors. This would be the basic information needed for data discovery and access under IOOS. If oceanographic metadata extensions are not available, use community accepted standards. In addition to updating existing metadata information for real-time data sets, also consider updating the metadata for the archived data sets. Documentation of data dictionaries used should be available to the end-user so that have all of the available knowledge about the data.

When updating the metadata, use an XML-schema with an XML style sheet, since the DMAC Steering Team (DMAC-ST) has adopted this method (April, 2005) for describing metadata. The DMAC-ST also recommends that when the metadata has been finalized; submit the metadata to the NASA Global Change Master Directory (GCMD http://gcmd.gsfc.nasa.gov) so that data sets can be easily found through an open data discovery process.

6. Goals for CO-OPS Participation in Fiscal Year 2006

6.1 Serve as Data Ingestion and Disseminating Site

To stay involved with IOOS activities beyond improvement in metadata standards, establishing CO-OPS as a data ingestion and dissemination provider will allow easier access not only to CO-OPS data, but also to similar data from other facilities. To

facilitate this method data discovery, installation of a new server will aid in locating data and products through metadata searches.

The DMAC-ST has made several recommendations for data providers concerning the types of servers to be installed. For gridded data, servers should provide access through the OPeNDAP data access protocol. For complex data, such as collections in a relational database (SQL), make data accessible to DMAC by participating in data transport pilot activities to use either (1) OPeNDAP relational data base server or (2) use enterprise GIS protocols. Finally, for large collections of individual files that comprise of a single (logical) data set, if OPeNDAP servers exist for the file types install these servers to provide access to the individual files.

Once the data has been located on a server, a suite of web services will be used to transport the data to the client. Currently, it is assumed that compatible interfaces will be SOAP (Simple Object Access Protocol) -enabled.

6.2 Help Develop a Web Portal Used to Extract the Real-time and Archived Data

To access the real time and archived data, an OPeNDAP (Open source Project for a Network Data Access Protocol) server will be installed. This server makes data available to the user via well-established and easy to use web protocols, such as HTTP (Hyper Text Transfer Protocol). In addition to using established protocols, OPeNDAP provides a common representation of the data in a variety of formats (ASCII, Binary, netCDF, etc…). This variety of formats gives the user more flexibility when downloading data. For example, if data is retrieved from multiple sites but in the same format, the user will only have one set of routines to convert the data into a preferred format if they do not want the data in the format provided.

For initial search capabilities, OPeNDAP provides three methods of data discovery information display. The first is the Dataset Descriptor Structure (DDS). This information gives a description of the data structure or its global attributes. This information may be station identifiers, starting and ending times, data type and who maintains the data. The second option is the Data Attribute Structure (DAS). This display contains information about the individual data, such as the variable names, units, type and quality control information. The third method for displaying the data is accomplished by using a HTML (Hypertext Markup Language) information page. This page presents the data in a more readable format and describes the information more completely by using both the DDS and the DAS.

On the HTML request form page, OPeNDAP provides the user with the ability to select the entire file to download for a particular variable or create a sub-sampling of the data of interest to them. The sub-sampling of data is accomplished by building a URL (Uniform Resource Locators) through selection of individual data types as well as implementing Boolean expressions depending on the parameter selected. An advantage that OPeNDAP has is that once the URL expression has been created, automated processes to retrieve data can use this URL.

Later development of more advanced web interfaces will allow searching for geo- and time- referenced graphics and data. The improved search parameters may include geospatial location, temporal information, keywords, controlled vocabulary items and some free text. These additional search capabilities would tailor the display with only those parameters of interest to the user in the HTML page versus all of the information given in the DAS information section of the HTML page. Overall, as new and modified browse capabilities are develop, the current design of web interfaces must allow for future growth.

A draft of the proposed IOOS web portal design is shown below. This web portal gives users access to ongoing CO-OPS IOOS activities, web service programs to retrieve CO-OPS data programmatically and allow access to the OPeNDAP servers. This site will also provide documentation on installation and use of the OPeNDAP servers and web services, description of CO-OPS' metadata formats and a listing a quality control and assurance standards used by CO-OPS and their partners.

Figure 1 Draft of proposed CO-OPS IOOS web portal design.

Several benefits for using this type of web portal versus a static HTML web page are it allows for easier collaborations and contributions for posting content on the pages by groups and users with appropriate privileges and promotes cooperativeness among

parties with similar interest. In addition, it captures the dynamic nature of the provided content by allowing rapid and easy update of new information and establishes new channels for communication between users and data providers.

6.3 Serve as Archiving Site

Another method in which CO-OPS will play an important role is as an archiving site. By following set archiving standards, the ability to securely archive data and metadata, as well as being able to retrieve the data, will allow search capabilities through archived data as seamless as searching through real time data.

To improve CO-OPS' archiving procedures, there is an Archive Project in progress. The objective of this project is to develop and implement an integrated data storage and retrieval solution that provides flexibility in interfacing with the many Coastal Observation Technology Systems (COTS). This activity will determine the best type of media that could be used for permanent storage and ease of duplication for user requests. Formats will be documented and designed for easy user access. As a part of this activity, CO-OPS must implement an active data archive for answering data requests for currents and water levels.

Even though the undertaking of this archiving project is separate from IOOS activities, in the near future it will be possible to use the improved archiving techniques to aid with data discovery and retrieval.

6.4 Assist in Gathering User Feedback

As data portals become available to the end-user, eliciting responses about usability and possible improvements will help in creating better data search and transport mechanisms. Development of IOOS outreach programs to get the end users involved in providing feedback to improve the real-time and archival retrieval systems will be an invaluable resource in determining the usability, accuracy and documentation of the data and of the web service software.

7. Resources needed to Achieve Goals

7.1 Personnel

Making the IOOS vision of data searching, exchange and archiving a reality, a full-time IOOS team is in place to implement IOOS DMAC goals. Currently, this team consists of three people. The first person is the IOOS Coordinator who facilitates interactions with the external customers to see what value added products CO-OPS can provide. The second member is the IOOS DMAC Coordinator who examines how the implementation of the DMAC vision will proceed and finally, the third person is the IOOS Technical Coordinator who implements the hardware and software needed for data processing. While these three people are working toward implementing the overall DMAC goals, at

times, other resources within the Information Systems Division (ISD) will be brought in for their expertise in aiding to achieve the listed milestones. These specialists will consist of database managers, IT security, software programmers, network managers, data communications managers and web developers.

In addition to resources found within ISD, other environmental specialists that may be necessary are Oceanographers, Meteorologists, Data Modelers as well as other contacts from other organizations who have expertise in a particular scientific or computer area.

8. Spending Plan for Fiscal Year 2006

The spending plan for the fiscal year 2006 is limited to achieving several short-term goals listed in the DMAC guidance plan (Ocean.US, 2005). These guidelines recommend the format for metadata, type of data access protocol, archiving standards, limited IT security information and quality control and assurance information.

Maintenances cost associated with the server (3 year warranty then maintenance is under Overall Maintenance contract)	Costs to be determined
Software	
Training	
COTR	
Metadata travel and seminar costs – 3 visits/2 people	
Skills development classes – 4 classes @ $2500 each	
Travel to other IOOS sites/meetings – 6 trips/$1000 each	
Seeking professional help with writing and improving CO-OPS station metadata	

Table 1 Anticipated IOOS spending for FY2006

9. Milestones

In establishing the IOOS program within CO-OPS, the accomplishments of the following milestones by the end of the 2006 fiscal year are:

- Establish an IOOS data server

  By establishing a dedicated server for data retrieval, it can be optimally configured to support the entire web services needed to display data information and data retrieval. These web services can reside with the OPeNDAP server, thus eliminating many communication issues. In addition, by having a separate server for the IOOS program, it will not affect existing data servers if maintenance or upgrades are needed.
- Creating/updating metadata in an XML-schema with an XML style sheet

  Improving the metadata for all of the data will allow better search capabilities by the users, especially when implementation of improved

methods of searching by keywords or free form text is used. The improvement of the metadata also includes evaluating and determining which Markup Language (ML) style or using parts of several MLs to create a more diverse metadata schema.

- Creation of web services to use with data server

    Creating web services will not only improve the readability of available data but eventually, additional web services will improve search methods through the databases and retrieval of sub-sampling of data.

- Implementing search of databases with basic capabilities

    Creating a set of APIs (Application Program Interface) which describe the web services available will allow other developers and programmers to use them and to write their own so that they can access the database programmatically.

- Ability to exchange data

    Once the OPeNDAP server and basic web services are installed, the ability to search, sub-sample data and retrieve requested datasets would be the final goal for implementing the basic recommendations given by the DMAC-ST. This milestone covers two methods for exchanging data. The first method is providing service for the NetCDF model data files and the second method is providing service for the operational real-time databases.

- Generate documentation of server installation and web services

    Thorough documentation about how to install an OPeNDAP server and associated web services will be published. This will give outside entities information that they may use in implementing their own services or they may use the information as a "lessons-learn" reference.

- Create an IOOS oriented web page

    Establishing an IOOS oriented web page will provide an outlet for published documentation relating to how CO-OPS installed and implemented their data server and web services, listing IOOS related web sites that have beneficial information and it will create a place where outside users could make recommendations on how CO-OPS can improve their services.

A proposed Technical Plan written by the IOOS IT Coordinator discusses in detail how the previously described milestones, concerning hardware and software installation, will be accomplished.

ID	Task Name	Start	Finish	Duration	Q3 05			Q4 05			Q1 06			Q2 06			Q3 06		
					Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	Establish an IOOS data server	6/3/2005	6/17/2005	11d															
2	Create/update Metadata in XML-schema	7/1/2005	9/29/2006	326d															
3	Create web services to use with data server	7/1/2005	1/31/2006	153d															
4	Implement basic search capabilities	7/1/2005	1/31/2006	153d															
5	Ability to exchange data	6/15/2005	2/28/2006	185d															
6	Generate documentation of server installation and web services	7/18/2005	1/31/2006	142d															
7	Create an IOOS oriented web page	7/15/2005	10/14/2005	66d															

Figure 2 Fiscal Year 2006 Milestones

Current 2005 fiscal year activities that directly affect CO-OPS, within an IOOS context, that are continuing in fiscal year 2006:

- Complete an automated web-based field site metadata report
   This activity provides field operations the capability of updating metadata information about a site or sensor immediately instead of using paper reports. With the web-based metadata report, as metadata standards are added, new baseline information about the sensor can be added to the metadata information, thus providing value added information about the data for the uses. In addition, by having web-based metadata reports, it will be easier to keep the metadata IOOS compliant. This objective was funded at a cost of 150K.
- Build improved data model and document implementation of software process and data model standards
   Redesigning the operational databases used by CO-OPS so that all of the currents, water level, meteorological data and other related data are stored in the same database. This will improve data access and retrieval not only thorough current data retrieval practices including when using the OPeNDAP server. While implementing software for database integration, generation of documentation of the processes and database configuration involved will be written. This milestone has been funded at a cost of 100K.
- Purchase equipment required to support a DMAC-compliant Data Assembly Center
   This equipment will host the server for the Data Assembly Center. It has been budgeted for 150K for the development, equipment and labor support.

Funding for these four milestones is from monies designated previously in fiscal year 2005.

10. Project Communication

To communicate effectively the progress of CO-OPS IOOS progress to IOOS team

members, senior management and to other entities interested in the evolution of IOOS vision, several methods will be used. Presentations of monthly briefings and creation of monthly reports will show achievements toward the listed milestones, current activities on projects and near-term goals. Availability of these briefings and reports for general information within CO-OPS will be provided via an IOOS web page accessible through the CO-OPS home web page. For internal use, an IOOS project documentation page has been created (http://developers.co-ops.nos.noaa.gov/projects/ioos). On this page, the project objective, team members, presentations, documentation information and trip reports are available. A similar web site to the project documentation page that will be added to the CO-OPS web pages in the near future is a collaborative web site. An example of one is TikiWiki (http://www.tikiwiki.org/). This type of web site allows for a web-based collaboration tool were users could easily upload information to the site.

In addition to the briefings and reports, whenever technical documentation is written about the installation of hardware and software they will be added to the web sites. These documents will be written in accordance to ISD convention and along the Department of Energy's Systems Engineering Methodology. In addition, these documents will undergo peer reviews to verify logic and completeness of design and implementation plans.

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12. Acronyms

API	Application Program Interface
ASCII	American Standard code for Information Interchange
ADCP	Acoustic Doppler Current Profiler
Caro-COOPS	Carolinas Coastal Ocean Observing and Prediction System
COOP	
CO-OPS	Center for Operational Oceanographic Products and Services
COTS	Coastal Observation Technology Systems
CREX	Character Form for the Representation and Exchange
DAS	Data Attribute Structure
DDS	Dataset Descriptor Structure
DMAC	Data Management and Communications Plan
DMAC-ST	Data Management and Communication Steering Team
DNR	Division of Nearshore Research
FGDC	Federal Geographic Data Committee
FTP	File Transfer Protocol
GCMD	Global Change Master Directory
GLO	General Land Office
GOES	Geostationary Orbiting Environmental Satellites
GoMOOS	Gulf of Maine Ocean Observing System
HTTP	Hyper Text Transfer Protocol
IOOS	Integrated Ocean Observing System
ISD	Information Systems Division
ML	Markup Language
MLLW	Mean Lower Low Water
NCOP	National Current Observation Program
NCP	National Currents Program
netCDF	Network Common Data Form
NDBC	National Data Buoy Center
NODC	National Oceanographic Data Center
NOS	National Ocean Service
NWLOP	National Water Level Observation Program
NWS	National Weather Service
NYOFS	New York Harbor Observational Forecast System
OPeNDAP	Open source Project for a Network Data Access Protocol
ORF	Operations, Research and Facilities

PAC	Procurement, Acquisition and Construction
PICS	Ports Image Component System
PORTS®	Physical Oceanographic Real-Time System
SAE	Shaft Angle Encoder
SHEF	Standard Hydrometeorological Exchange Format
TCOON	Texas Coastal Ocean Observation Network
TCT	Tidal Current Tables
URL	Uniform Resource Locators
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WFO	Weather Forecast Office
XML	Extensible Markup Language

13. Appendix - Data Profile
13.1 Currents
    Parameter Information
        ADCPs – Acoustic Doppler Current Profilers

- RDI Instrument - RT-PORTS, Survey
  - Upward (4 beam) – floor
  - Horizontal (3 beam) Pier, Piling
  - Towing- Downward –Boat
  - RDI NarrowBand measures are: u, v and w velocities (mm/s), the error velocity, direction (degrees True), velocity (mm/s), echo amplitude (relative dB) for each of the four beams, percentage of good pings for each of the four beams (0 to 100), water temperature (°C), DQA bin specific bit mask, spectral width (0 to 255), bin status and raw beam counts used for current speed.

  - RDI BroadBand measures u, v and w velocities (mm/s), error velocity (mm/s), direction (degrees True), velocity (mm/s), echo amplitude (relative dB), percentage of good three beam solutions, percentage of transformations rejected, percentage with more than one beam bad in the bin, percentage of good four beam solutions, water temperature (°C), correlation coefficient for each of the four beams and beam status for each of the four beams.

RDI Upward   RDI Horizontal   RDI Towing

- SonTek –RT-PORTS
  - Side-looking (2 beam)
  - Upward-looking (3 beam)
  - SonTek Current Profiler measures u, v, w velocity (mm/s), direction (degrees True) velocity (mm/s), echo amplitude (relative dB), standard deviation for each of the three beams (mm/s) and water temperature (°C).

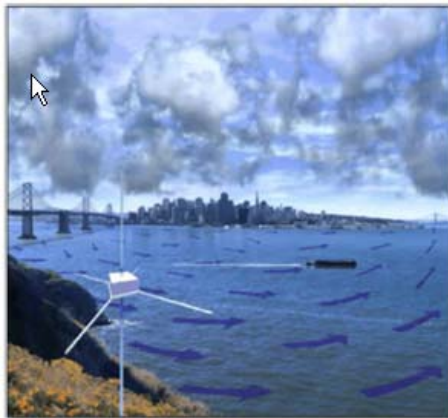SonTek - Side-looking   SonTek – Upward looking

- Nortek- Aids to Navigation buoy
  - Downward (3 beam)

Nortek – ATON

High Frequency Radar
- CODAR - Surveys
  - Scans the coasts

Data Frequency
- Every 6 minutes except for CODAR
- CODAR – hourly
- Towing – 2 seconds (self contained)

Quality Control
- o Raw Data Collection Requirements - This step checks the quality of the incoming data sets. Data needs to be in a standard format with standard units.
  All current meter sensors
  - ▪ Instrument heading rate of change exceeds threshold.
  - ▪ Current speed rate of change exceeds threshold.
  - ▪ Instrument pitch rate of change exceeds threshold.
  - ▪ Sampling rate invalid.
  - ▪ Water temperature rate of change exceeds threshold.
  - ▪ Water pressure rate of change exceeds threshold.

  All three and four beam current meter sensors
  - ▪ Vertical velocity rate of change exceeds threshold.
  All four beam RDI current meter sensors
  - ▪ Error velocity rate of change exceeds threshold.

  Bounds: This checks that the various physical and statistical parameters are within defined bounds.
  To become operational with some improvement:
  - - 2-beam : Time, ensemble, tilts, heading, speed direction, temperature, pressure, echo intensity, voltage, error, side lobe
  - - 3-beam: 2-beam plus - Vertical velocity, correlation magnitude, percent good, beam status
  - - 4-beam: 3-beam plus – error velocity

  No method or procedure exists for the following methods:
  - - Towing: 4-beam plus – Latitude, longitude, bottom tracking

  CODAR: These instruments collect a 2-dimensional grid of data points that make up a map of surface water velocities. The analysis of the data is new and many improvements in the quality control will evolve.
  - - Location, velocity, number of radial vectors, vector indicator flag, STDV (radial or elliptical standard deviation of current velocity over time), SCDV (radial or elliptical standard deviation of current velocity over area), SCMX (radial or elliptical maximum change of current velocity over area), distance from the origin, bearing, speed, heading, standard deviation, covariance
  Rate of Change: This checks that the rates of change (the change in the value from one time or ensemble to the next) of various physical and statistical parameters are within defined bounds.
  To become operational with some improvement:
  - - 2-Beam : Tilts, heading, speed, time, temperature, pressure
  - - 3-beam: 2-beam plus – vertical velocity
  - - 4-beam: 3-beam plus – error velocity

- Towing: same as 2-beam
  No method or procedure exists for the following methods:
- CODAR: rate of change checks yet to be determined

Leader Checks: All instruments output leaders (headers) that are comments giving metadata about the deployment and configuration of the instrument. After deployment and recovery, field personnel will input metadata regarding the fieldwork into a HQ database. These leaders need to be checked for accuracy against the human input data in the database and checked that this information does not change over the deployment of the instrument.
  To become operational with some improvement:
- 2-beam: Serial number, orientation, coordinate system, number of beams, temperature mode, number of bins, bin length, blanking distance, sampling interval, number of pings, sensor mode, number of pings per ensemble
- 3-beam: same as 2-beam
- 4-beam: same as 2-beam plus configuration
- Towing: same as 2-beam
  No method or procedure exists for the following methods:
- CODAR: time, site name

Time Series Graphs: The following are graphs plotted over time that will help the user visualize the quality of the data.
  To become operational with some improvement:
- 2-beam: echo intensity, tilts, heading, temperature, pressure, velocity, contour, scatter
- 3-beam: same as 2-beam
- 4-beam:same as 2-beam plus % good, correlation magnitude
- Towing: same as 2-beam plus transect
  No method or procedure exists for the following methods:
- CODAR: needs to be determined

o Analysis used – Types of routines used to process the data
   Currently operational:
   ▪ 2-Beam: Determine the principal axis of flow from 0 to 180 degrees, Uses predictions to subtract non-tidal signals from the current observations, Uses harmonic constants to derive theoretical values, Greenwich Interval Analysis, Average of the constituents, Determine a set of constituents by reversing and reduction analysis, Harmonic Analysis routine used for data sets between 15 days and 29 days in length, Harmonic Analysis routine used for data sets greater than 29 days in length, Determine a set of constituents of stations that exhibit a non-rectilinear current, Harmonic Analysis routine used for data sets greater than 29 days in length that uses least squares analysis
   ▪ 3-Beam: same as 2-beam

- 4-Beam: same as 2-beam

  <u>No method or procedure exists for the following methods:</u>
  - Towing: same as 2-beam plus discharge analysis
  - CODAR: same as 2-beam plus spatial analysis and trajectory simulations

- o Analysis Quality Control: The following are quality control routines that determine the quality of the output from the analysis
  <u>Action:</u> The statistical and mathematical routines that quantitatively determine the quality of the analysis output
  - For all beams and Towing:
    <u>Currently operational:</u>
    Check Greenwich Intervals, Tidal Ellipse, Calculate Moments of Distribution
    <u>To become operational with some improvement:</u>
    - Check constituent instabilities of the Harmonic Constants, Empirical Orthogonal Function Analysis, spatial Analysis, Distribution Analysis, Root Mean Square, Comparisons, Vertical Velocity, Pressure and Mean Lower Low Water
    <u>No method or procedure exists for the following methods:</u>
    - Correlations, Spectral Analysis
    - 3-beam and 4-beam: Vertical Velocity

- o Negative causal factors
- o Problems with the data
  - Fish swimming through signals
  - Ships passing through
  - Sliding/shifting
  - Ships hitting them
  - Being knocked over
  - Marine growth
  - Nortek - the magnetic effect steel hull is not completely known.

Products Disseminated
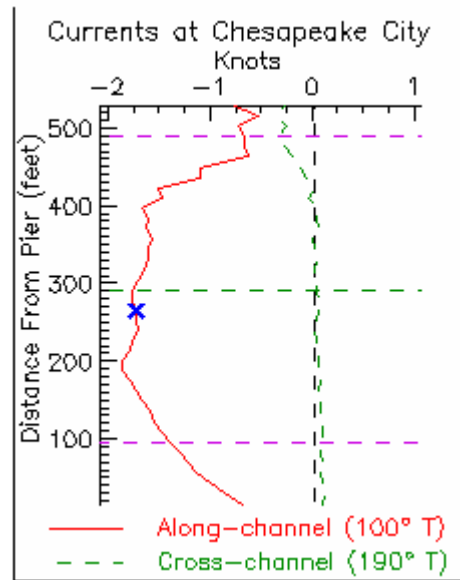
Figure 3 Composite – Along channel and Cross channel Depth (feet) Below MLLW vs. Knots
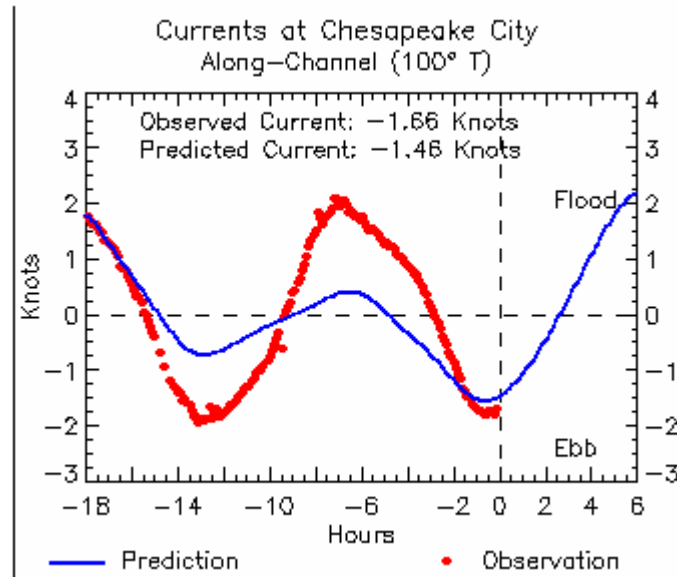

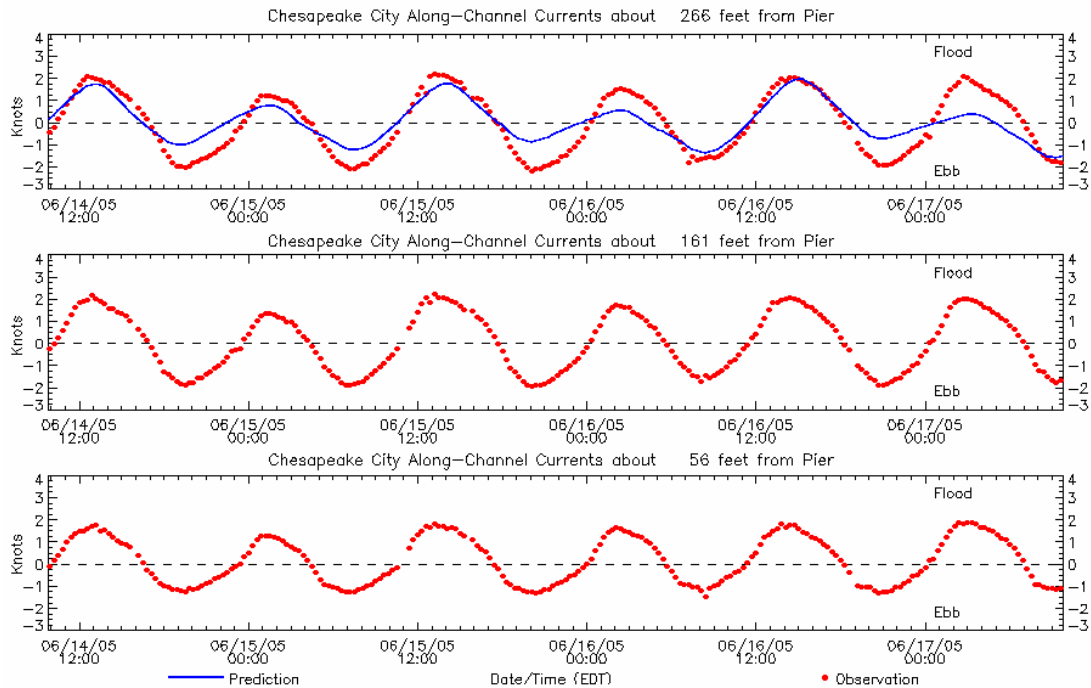**Figure 4 Composite – Along-channel – Predicted with Observed Knots vs. Hours**
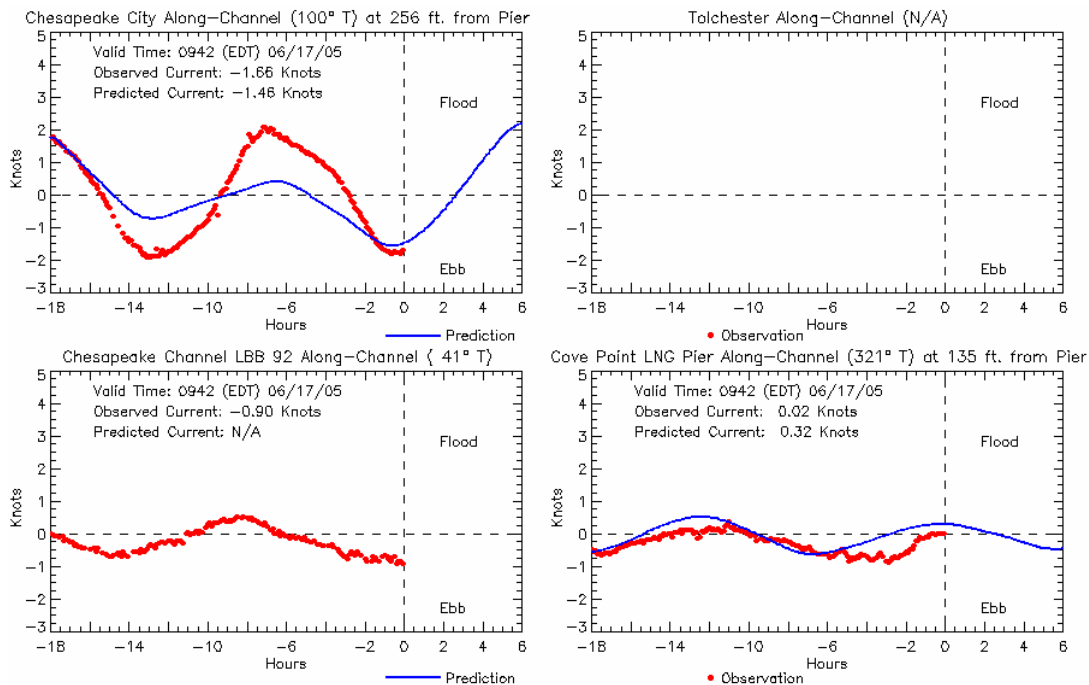
Figure 5 Composite - 3 Days Currents

Figure 6 Composite - All currents

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Archived
- RT-PORTS – Monthly
  Current speed, Current direction, Depth, Ensemble number, Pitch, Roll, Heading, Echo intensity, Number of Pings, East velocity, North Velocity, Vertical velocity, Error velocity (RDI), Standard Deviation (SonTek), Correlation Magnitude (RDI), Percent good pings (RDI)
- Surveys – End of Project
  Same as above, plus Current vectors (CODAR), site Radials (CODAR), Cross Spectral (CODAR)

Anticipated or Ongoing activities
- Working on nearest neighbor QC
- Gradient check QC

13.2 Water Levels

Parameter Information
- Aquatrak Water Level Gauge
  - GOES
- Strain Gauge
  - GOES
- SAE – Shaft Angle Encoder
  - GOES
- Tsunami
- Observations

Data Frequency
- Every 6 minutes

Quality Control
- Existing Quality Control Checks
  - Observed datum or sensor offset incorrect
  - Outside of Min/Max threshold
  - Water Level unchanging (i.e. flat line)
  - Rate of change exceeds threshold
  - Sigma exceeds threshold
  - Outlier exceeds threshold
  - Primary/backup water level range exceeds threshold
  - Prediction comparison exceeds threshold
  - Height correction exceeds height corrections threshold
  - Temperature gradient exceeds threshold
  - Prediction comparison exceeds threshold
  - Height correction exceeds threshold (Not presently applied)
  No method or procedure exists for the following methods:
  Phase analysis and phase plots
- Negative causal factors
- Problems with the data
  - Leaking fittings – loss of pressure
  - Orifice is clogged or buried
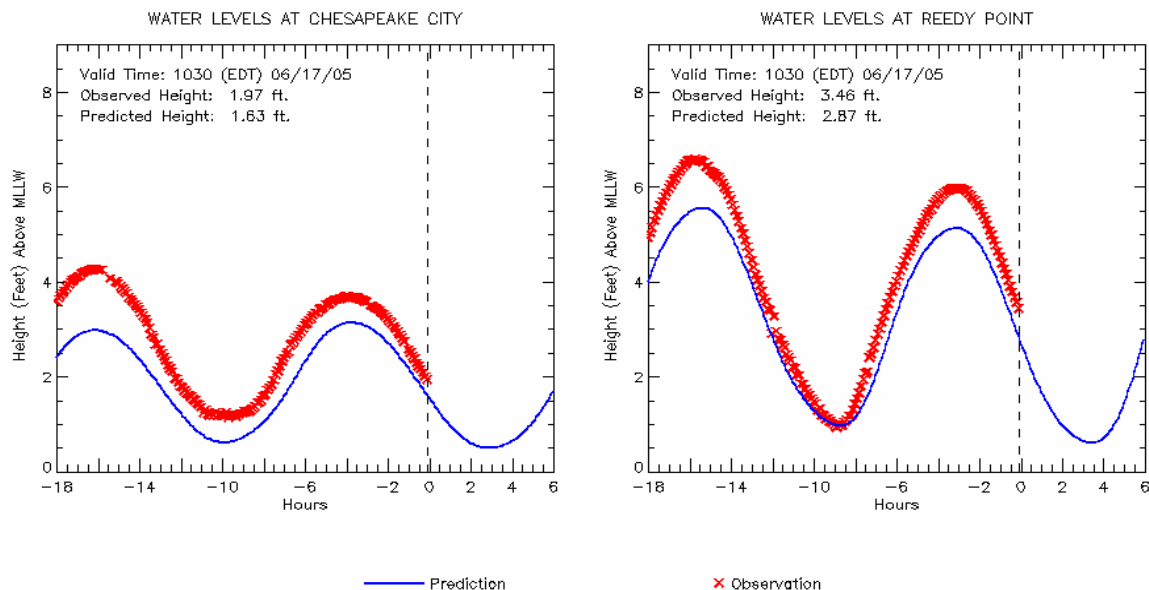
- Bad sensor head

Products Disseminated

Figure 7 Water Levels composite – Predicted and Observed – Height (feet) above MLLW vs. Hours
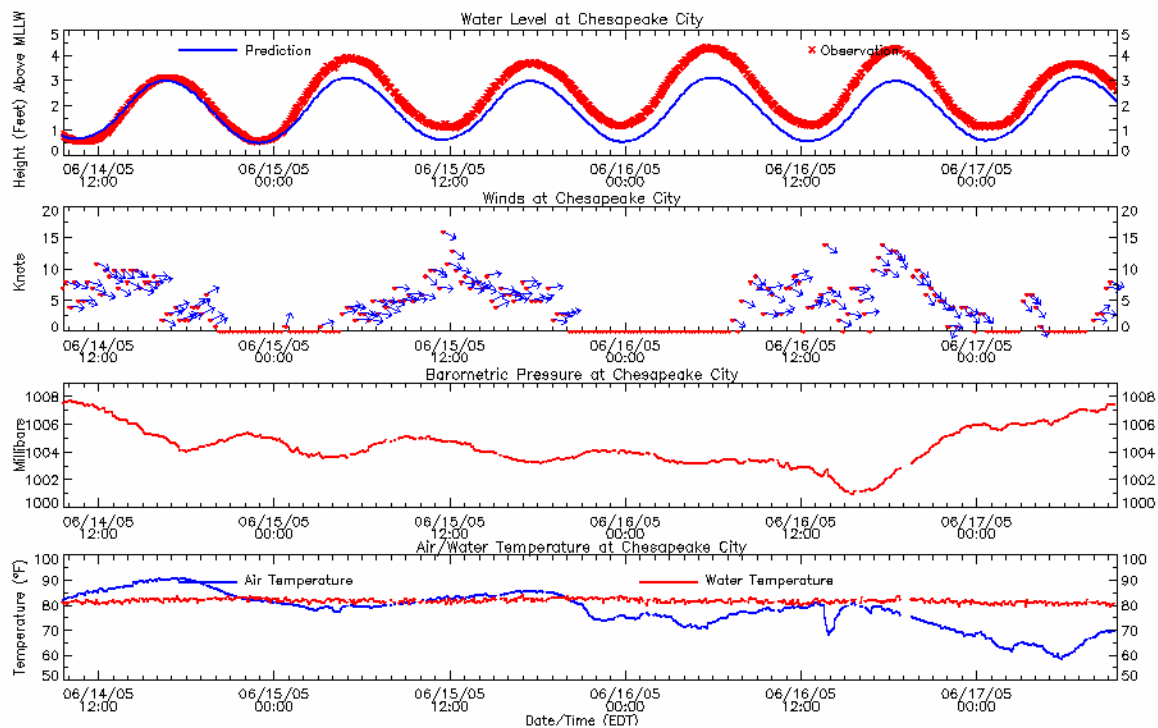

Figure 8 3-Days Water Levels and Meteorology

Archived
- o Monthly
  - ▪ Water Levels
- o Observations also have Hourly Heights, High/Low water levels, Daily Means, Monthly Means and Yearly Means calculated. These are stored monthly as well.

Anticipated or Ongoing Activities

13.3 CT Probes

Parameter Information
- o Conductivity
  - ▪ Falmouth or Greenspan - GOES
- o Salinity
  - ▪ Falmouth or Greenspan - GOES
- o Water Temperature
  - ▪ RDI Instruments – RT-PORTS, Surveys
  - ▪ SonTek - RT-PORTS, Surveys
  - ▪ Nortek - RT-PORTS
  - ▪ Yellow Springs - RT-PORTS, GOES
  - ▪ Falmouth or Greenspan - GOES

Data Frequency
- o Every 6 minutes

Quality Control
- o Collection Requirements
  - ▪ Rate of Change threshold exceeded for water temperature
  - ▪ Min/Max thresholds exceeded for salinity, water temperature
- o Negative causal factors
- o Problems with the data
  - ▪ Bad salinity sensors
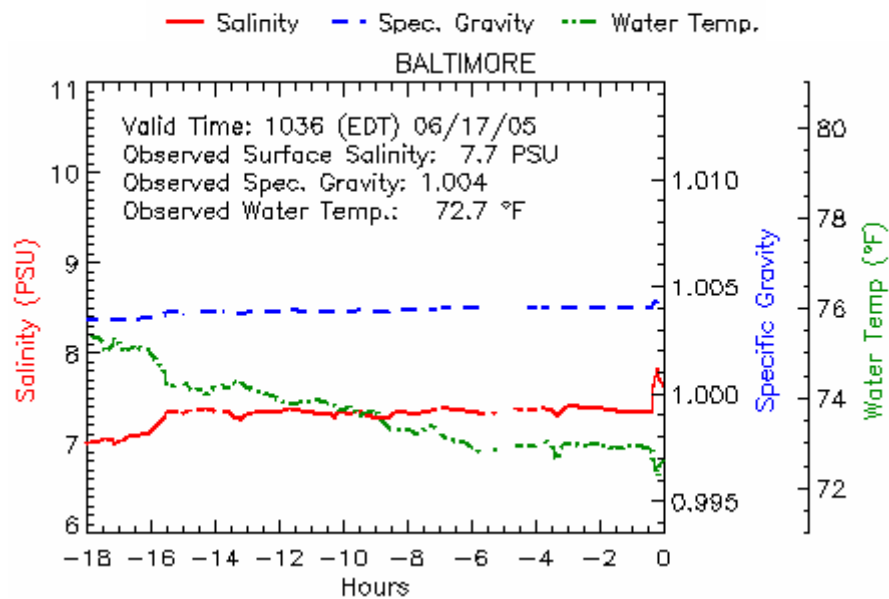 - ▪ Fouled by debris and algae growth

Products Disseminated
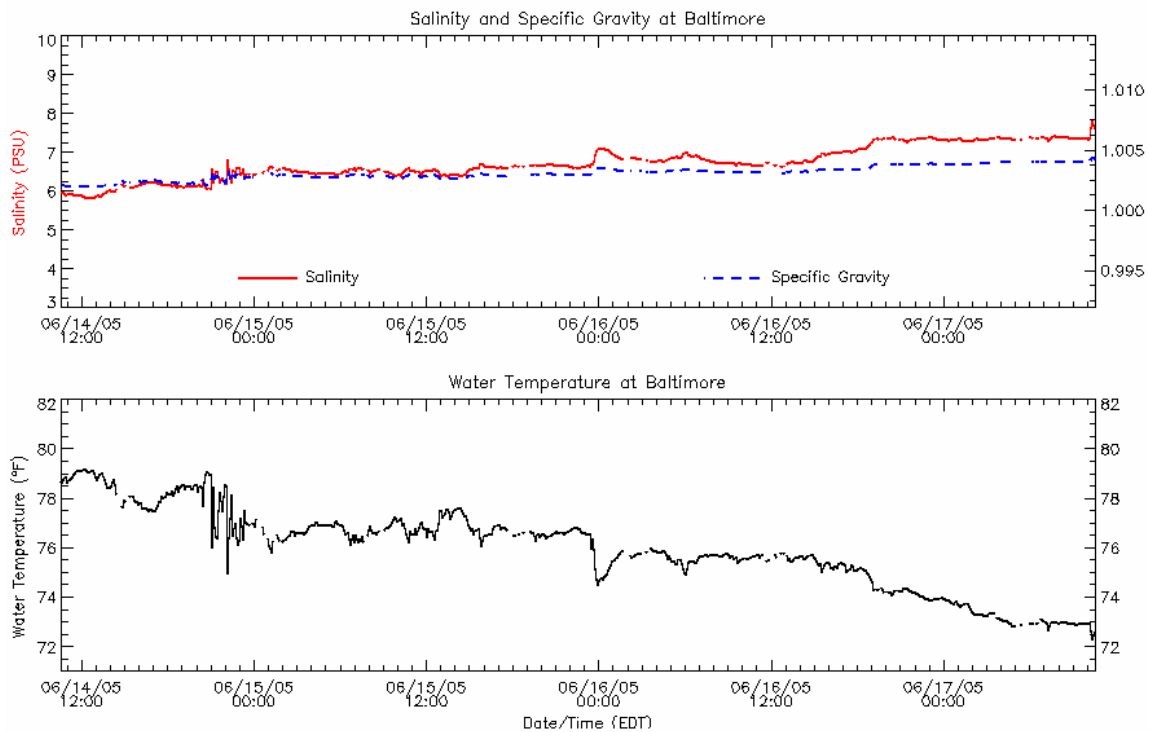

Figure 9 All CT

Figure 10 3-Day Composite of Salinity/Specific Gravity/Water Temperature vs. Time

Archived
- o RT-PORTS and GOES- monthly
  - ▪ Conductivity, Salinity, Water Temperature

30

- o Surveys – End of Project
  - Water Temperature
- Anticipated or Ongoing Activities

13.4 Meteorological Data
Parameter Information
- o Wind
  - Coastal Climate Met. Pack – RT-PORTS, GOES
  - R. M. Young - GOES
- o Barometric Pressure
  - Coastal Climate Met. Pack – RT-PORTS, GOES
  - Setra or Vaisala - GOES
- o Air Temperature
  - Coastal Climate Met. Pack – RT-PORTS, GOES
  - Yellow Springs - GOES
Data Frequency
- o RT-PORTS and GOES – every 6 minutes
- o GOES Coastal Climate Met. Pack - hourly

Quality Control
- o Collection Requirements
  - Rate of Change threshold exceeded for wind speed, water temperature, air temperature, barometric pressure
  - Exceed Min/Max thresholds for air temperature, barometric pressure, wind speed, wind direction, wind gusts
  - Wind direction or speed difference between primary and secondary sensors exceeds threshold
  - Invalid wind direction
- o Negative causal factors
- o Problems with the data
  - Barometer – incorrect height calculation
Products Disseminated
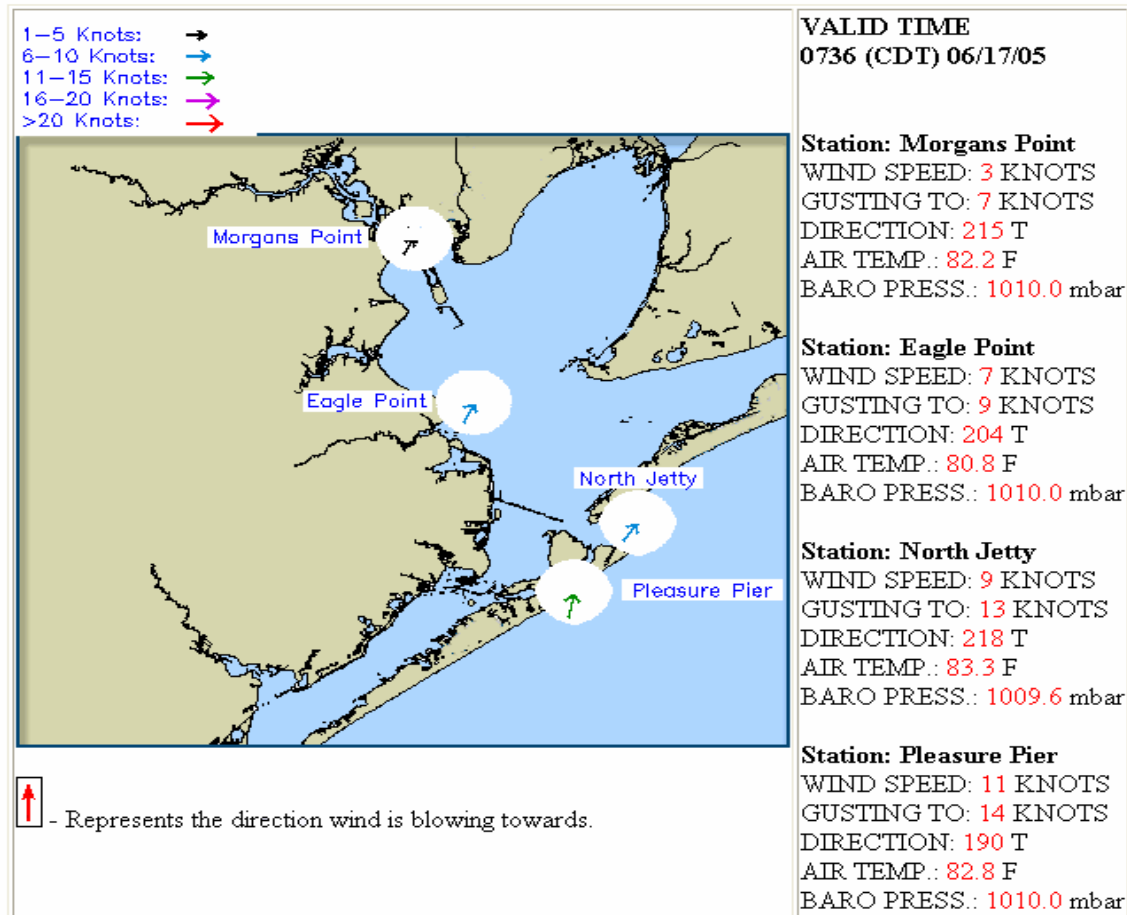   See also 3 Days Water Levels and Meteorology

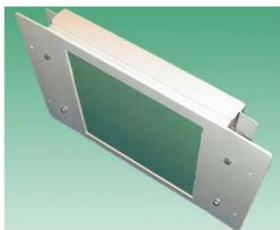**Figure 11 All Meteorological Data**

Archived
- o Monthly
  - ▪ Wind speed, wind direction, wind gusts, Barometric pressure, Air temperature

Anticipated or Ongoing Activities

13.5 Air Gap

Parameter Information
- o Miros SM094/50 - RT-PORTS
  - ▪ Downward – bridge

Data Frequency
- o Every 6 minutes

Quality Control
- o Collection Requirements
  - ▪ using the same algorithm used for CO-OPS water level observations
  - ▪ Over a three minute period centered on each tenth of an hour, 181 instantaneous one-second water level samples are averaged
  - ▪ A three standard deviation outlier rejection test is applied, the mean and standard deviation is recalculated and reported along with the number of outliers
  - ▪ Air gap observations are automatically flagged as bad by the Continuously Operational Real-time Monitoring System (CORMS) whenever any one of a variety of thresholds are exceeded, including observed datum or sensor offset incorrect, minimum or maximum value, high standard deviation, high outlier count, high rate of change, or flat line readings.

Negative causal factors

Problems with the data
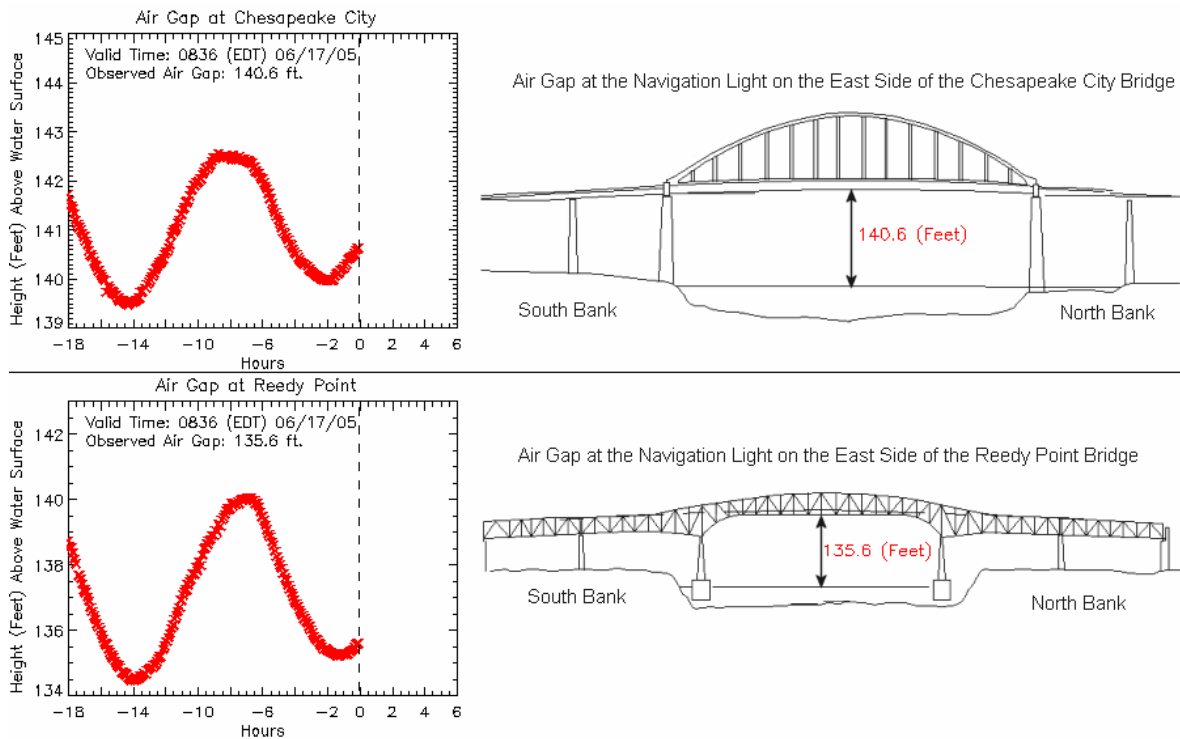
Products Disseminated
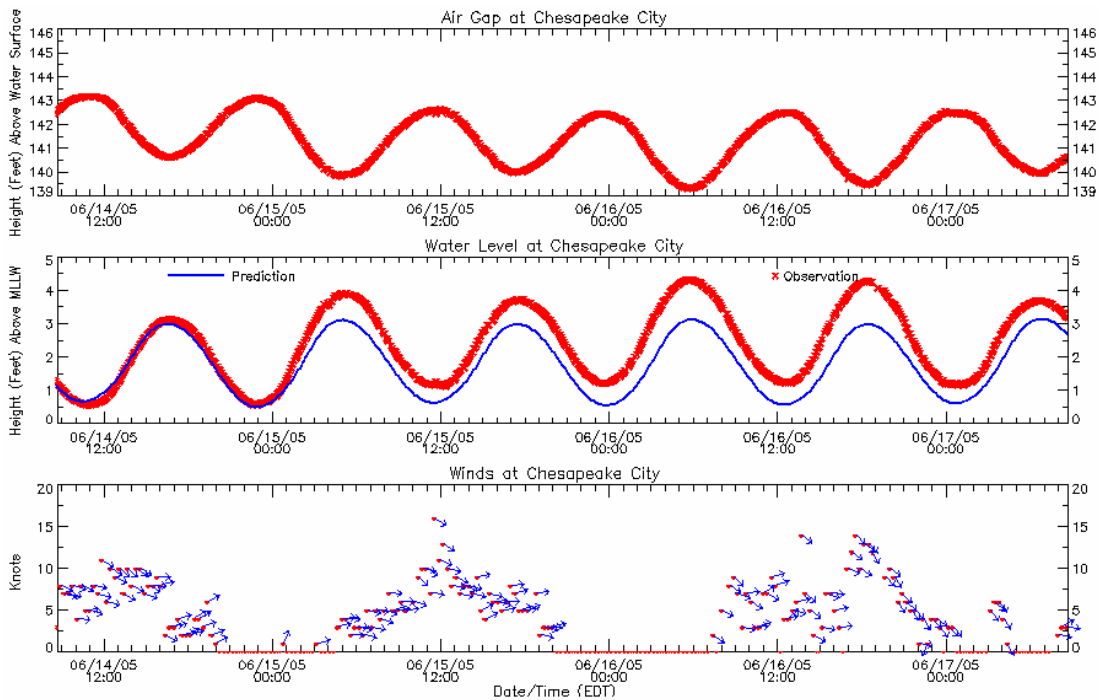

Figure 12 Air Gap – Composite

Figure 13 3-Day Air Gap – Composite

Archived
Anticipated or Ongoing Activities

13.6 Wave Meter
Parameter Information
- RDI Instrument (4 beam)
  - Wave pattern

Current velocity
Data Frequency
- Every 0.5 seconds

Quality control
- Currently operational: N/A
- To become operational with some improvement: N/A
- No method or procedure exists for the following methods:
  - Bounds: All of those listed for 4-beam currents QC plus wave bounds
  - Rate of change: same as 2-beam
  - Leader Check: same as 2-beam plus wave leader
  - Time Series Graphs: same as 2-beam plus waves
  - Analysis: same as 2-beam plus wave frequency
  - Action: same as all beams plus direction/frequency polar and frequency
  and energy.

Products Disseminated
Archived
Anticipated or Ongoing Activities